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A monthly survey of programs and findings of the International Geophysical Year and the International Geophysical Cooperation-1959 as related primarily to United States programs.

Unusual Radio-Signal Enhancement in the Far East

The following report is based on material supplied by J. W. Finney, E. K. Smith, L. H. Tveten, and J. M. Watts, of the Central Radio Propagation Laboratory, National Bureau of Standards' Boulder Laboratories, and Ross Bateman, of Page Communications Engineers, Inc. A more detailed account was published in the Journal of Geophysical Research, *April 1959.*

Radio propagation studies in the eastern Pacific just prior to and during the IGY revealed an anomalous increase in the intensity of very-high-frequency (VHF) radio signals over several propagation paths between the Philippines and Okinawa. The enhancement occurred during the evening, beginning about two hours after sunset and lasting until about midnight. It was particularly strong during the autumnal equinox.

Signals with frequencies above about 30 megacycles per second are not generally reflected by the ionosphere, but penetrate it completely and continue into space. Under certain special conditions, however, generally by "scatter" and by "sporadic-E" propagation, ionospheric transmission may be effected at frequencies up to about 100 mc/sec. Scattering results from irregularity of surfaces of equal ionization density in the ionosphere or from discontinuity of the electron density at some level; generally, such turbulent conditions result in partial reflection of the original wave energy up to frequencies considerably higher than normal. Sporadic E is probably the result of reflections from clouds or patches of unusually high ionization in the E region of the ionosphere.

Propagation of VHF radio signals along paths between the Philippines and Okinawa normally takes place by scatter in the lower ionosphere or, occasionally, by sporadic E. The IGY equipment that monitored the enhanced signals was originally set up by the Central Radio Propagation Laboratory (CRPL) to measure sporadic-E propagation. However, the abnormal signal enhancement observed along these paths was often as much as 30–40 decibels above normal at a frequency of about 50 mc/sec, and 40–50 db above normal at about 36 mc/sec.

The experiments described were made with the cooperation of the Voice of America, the US Army IGY Support Group, and the Philippine IGY Committee.

Observational Circuits

The anomalous enhancement was first measured over an experimental circuit at 36.4 mc/sec between Poro Point, Philippine Islands, and Sobe, Okinawa (1329 kilometers), operated from May 1956 to

May 1957. The IGY circuit designed to measure sporadic E began operating in September 1957 at 49.84 mc/sec over a nearly identical, 1347-kilometer circuit between Poro Point, P. I., and Onna, Okinawa.

During the May 1956–1957 period of operation at 36.4 mc/sec, peaks in the number of occurrences of the evening enhancement were reached during both the spring and fall equinoctial periods. In the following year, however, at 49.84 mc/sec, only the fall peak was observed; during the 1957 spring equinox, in fact, there appeared to be a minimum in the number of occurrences.

Figure 1 is a graph showing monthly medians of hourly median signal intensities for both propagation paths during the months of October and November 1956 and 1957. It can be seen that in both years October was a month in which the anomaly occurred very often and November was a month of few occurrences.

Based on the observations at 50 mc/sec and below, it has been estimated that the intensity of the anomalous signal decreases by about one decibel for each megacycle of frequency increase. If this estimate is also valid for frequencies above 50 mc/sec, it may be possible to distinguish the unusual enhancement to frequencies as high as 80–90 mc/sec.

An additional propagation path was set up between Okinawa and the Manila area to observe the behavior of the anomaly. Southbound transmissions were at 36.4 mc/sec. At each terminal, dipole antennas were

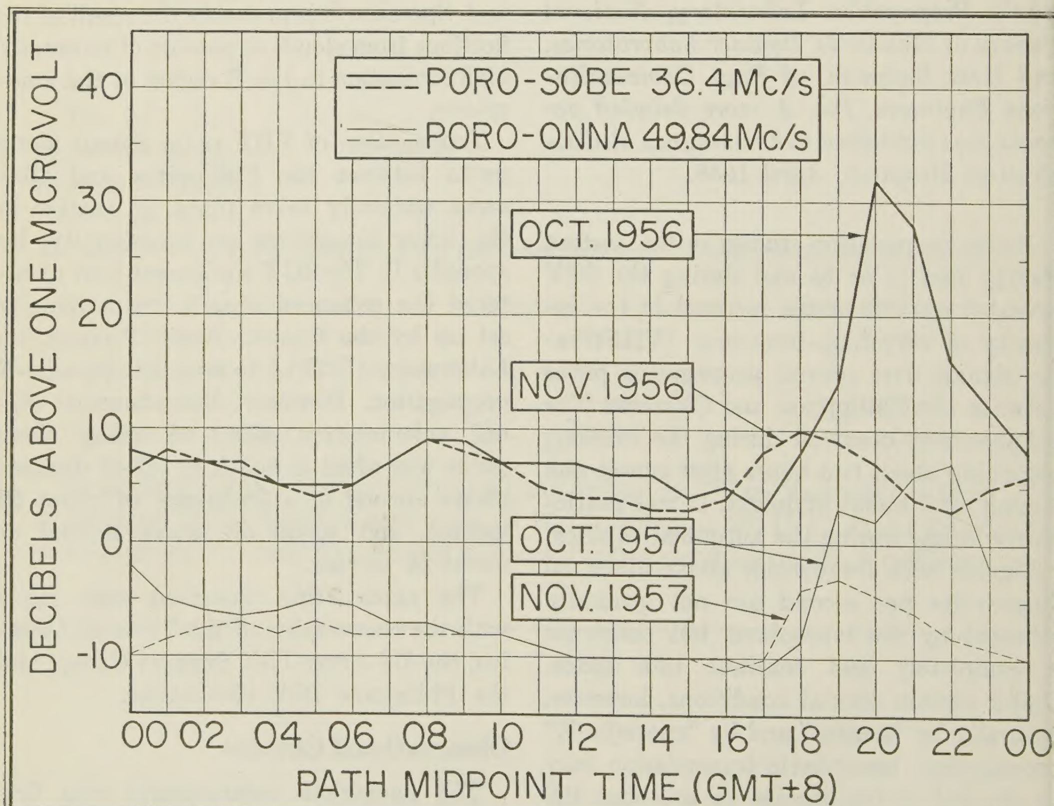

FIG. 1. *Curves of Monthly Medians of Hourly Median Signal Intensities Over the Two Philippines-Okinawa Propagation Paths. The evening-hour intensity increase is clearly shown, as well as the tendency for the enhancement to occur frequently in October and relatively infrequently in November.*

alternated at half-hour intervals with corner-reflector antennas. For the northbound transmissions, at 40.2 mc/sec, antennas beamed on the great-circle path between the two points were alternated at half-hour intervals with symmetrical split-beam antennas at each end. The split-beam antennas had a radiation pattern with beam maxima about 8° on each side of the great-circle path, and a "null" along the great-circle path itself.

It appears that most of the time during periods of abnormally enhanced propagation, the signals arrive from directions predominantly on one side or the other of the great-circle bearing. Occasionally, and particularly during the later stages of the periods of enhancement, extremely strong signals were received along the great-circle path. During these times, the intensity of signals observed with the split-beam antennas was characteristically lower than the intensity of signals received with the "normal" beam.

Pulse Experiments

Pulse measurements were made over the Poro Point-Onna path in September 1958. In such experiments, short, pulsed signals are sent into the ionosphere and the time between transmission and reception is measured. Assuming that radio signals travel at the speed of light, the height of the reflecting layer can then be computed.

For the pulse experiment, a peak pulse power of two kilowatts was used and independent time standards were employed to control the pulse repetition rate (100/sec) at the transmitter and the oscilloscope sweep rate at the receiver. Records were obtained for four nights. The normal E-region echo was shown at the bottom of each record so that the time delay of the abnormal echo could be compared to it.

The records for both September 22 and 23, 1958, show an abrupt start of the anomalous signal at a time delay of about 1200 microseconds behind the E-region pulse. The commencement time for the anomalous signal was 1924 (local time) on September 22 and 1911 on September 23. On the 22nd, the delay time had decreased to 500 microseconds by 2300 and on the 23rd it fell to 600 at 2130, after which the E-region echo dropped out entirely.

A delay of 400 microseconds relative to the E-region echo corresponds geometrically to a reflection height of about 300 kilometers at the mid-point of the great-circle path; a delay of 1100 microseconds corresponds to a height of about 500 kilometers. Small lateral deviations from the great-circle path would not materially affect these figures. The transmitted pulse —50 microseconds long—was broadened to approximately 1500 microseconds in the earlier hours; this value decreased to less than 500 microseconds in the later stages of the enhanced propagation.

Comparisons with Other Stations

The periods of anomalous propagation over the Poro Point-to-Onna path during September 1957 were compared with ionospheric data from the ionosphere stations at Baguio, P. I., and on Okinawa. No association could be found between the anomaly and E-region effects. The abnormal propagation periods did, however, appear to correspond to periods of spread-F propagation at Baguio and of high F2 critical frequencies at Okinawa, where spread F is comparatively rare. (Spread echoes are scattered through a frequency range of several megacycles instead of remaining at the transmission frequency. Spread-F scattering occurs in the F region of the ionosphere. Critical frequencies are the maximum frequencies reflected by the individual ionospheric layers. Critical frequencies vary with ionosphere conditions.)

Values of the F2 critical frequency observed at the Okinawa ionosphere station in the evening hours are among the highest

in the world. The F2 maximum usable frequency (MUF) for the Poro Point-Onna propagation path is often as high as 35 mc/sec, and may have reached 40 mc/sec on at least one occasion. It might be argued, therefore, that the unusually intense propagation in the 35–40 mc/sec range derives from some peculiarity related to the F2 critical frequency. However, the fact that this anomaly has also been observed at approximately 50 mc/sec makes this hypothesis untenable.

Recent measurements during the enhancement indicate a fading rate on the order of 5 cycles/sec at a frequency of 50 mc/sec. This is approximately the same as the fading rate for normal scatter fading; the fading rate for periods of sporadic-E transmission, however, is usually much lower.

There is some evidence of a small negative correlation with magnetic activity. At the mid-points of the Philippines-to-Okinawa propagation paths, the magnetic dip of the ionosphere is about 28°. A circuit from Panama to Guayaquil, Ecuador, operated at 50 mc/sec by the National Bureau of Standards in the latter part of the IGY, although having roughly the same magnetic configuration as the Philipines-Okinawa paths, has shown few occurrences of the abnormal signal enhancement. Some observations of what appears to be the same anomaly have been made on winter nights at 50 mc/sec over a path between Panama and the US Naval Base at Guantanamo Bay, Cuba. This path has a magnetic inclination of 44° at mid-point.

Conclusions

The investigators believe that results of the experiments described indicate that the anomalously intense signal is propagated via the F region of the ionosphere and is associated with low-latitude spread F, as observed with ionosphere sounders. The relatively well-defined lower edge of the anomalous echo (usually present in visual records of scattered signals) can be interpreted in either of two ways: (1) It may represent the limiting geometric distance to the lowest stratum of ionized "blobs" in the F region; or (2) it may be the closest approach of the locus of the specular, or reflecting, condition in the F region that permits optimum scattering from blobs of ionization aligned parallel with the earth's magnetic field. The investigators consider the latter interpretation more probable.

Aurora Observations at the South Pole

This report is based on material prepared by C. W. Gartlein, B. Nack, and G. Sprague of the IGY Visual Auroral Data Center, Cornell University.

Three main conclusions have been drawn from aurora observations at the South Pole and other US-IGY Antarctic stations. They concern the location of the auroral zone; the daily shift of the position of the zone, and the effects of twilight on auroral reporting.

The results of visual auroral observations at US-IGY South Pole Station have a special interest because of the relatively fixed relation between the observers and the sun. In particular, the sun maintains an almost constant depression below the horizon for forty days starting at the first of June. Hence, auroral observations for

this time and place are not complicated by the effect of twilight on visibility.

Auroral Distribution

The South Pole observations show that, within the region circled by the zone of maximum auroral frequency (see Fig. 2), there is a definite increase in the number of overhead auroras with distance from the geomagnetic pole. Taking into account similar data from other US-IGY stations, it appears that the southern region of maximum aurora frequency is outside (north of) NAF McMurdo and Little America, Byrd, Wilkes, and the South Pole Stations, but inside Ellsworth Station.

Based on South Pole and other auroral observations, together with theoretical calculations based on the earth's magnetic field, the authors have determined the approximate positions of three major boundaries of auroral activity. These boundaries are shown in Fig. 2.

Line A represents the outermost edge of the biggest auroras seen during the IGY. This boundary passes between the two main islands of New Zealand.

Line B is the outermost edge of the region in which the greatest number of au-

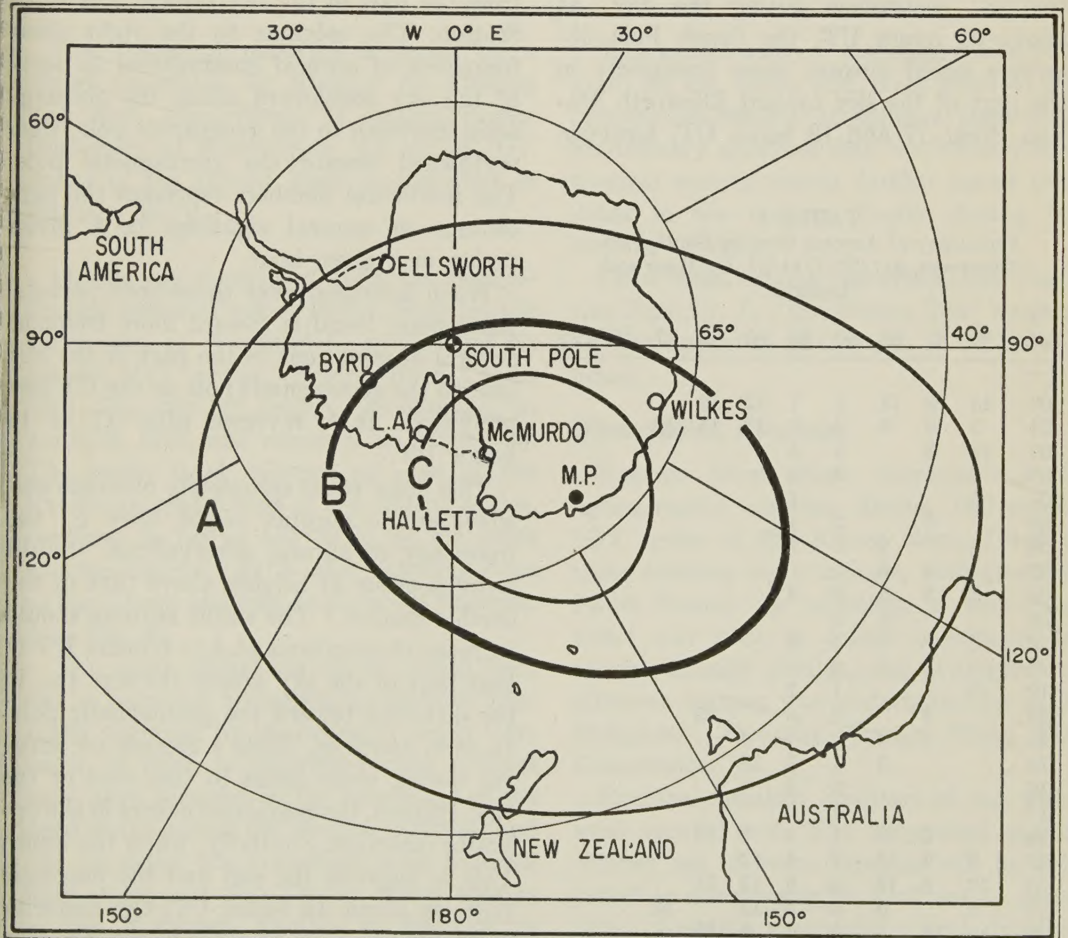

FIG. 2. *Aurora Australis. Line A represents the outermost edge of the biggest auroras seen from the South Pole and other stations during the IGY. Line B is the outer edge of the region where the greatest number of auroras are seen. Line C bounds a zone inside which "irregular" auroras occur. LA identifies Little America Station, MP the magnetic pole.*

roras are seen, and therefore is an approximation of the southern auroral zone.

Auroras occurring inside C are somewhat different from those reported outside C in that arc forms and flames are not seen. Instead, the display consists of rays and surfaces; both are distributed in patches and the small individual features are of short duration, giving a flickering appearance rather than regular pulsations.

Daily Motion

A noteworthy feature of the auroral distribution is a shift in the latitude of most frequent occurrence during the day. At about 01 hours UT, the South Pole observers noted auroras most frequently in the part of the sky toward Ellsworth Station. Near 17 and 18 hours UT, however, the concentration had shifted to the opposite part of the sky, or toward the geomagnetic pole. (See *Bulletin No. 12* for method of calculating ground point over which aurora occurs.)

Table 1 indicates the frequency of auroras seen by South Pole observers at different hours of the day in different parts of the sky along their geomagnetic meridian (i.e., the meridian from the geomagnetic pole that passes through the zenith point above the station). The parts of the sky are identified in term of degrees of geographic latitude along this geomagnetic meridian. The tabulation starts at the left from the part of the sky toward Ellsworth Station. The columns to the right show frequency of auroral observations in parts of the sky southward along the geomagnetic meridian to the geographic pole, then northward toward the geomagnetic pole. The individual numbers represent the percentage of auroral sightings in a given region in a given hour.

When averaged over three-hour periods the general trend is toward more frequent auroral observations in the part of the sky toward the geomagnetic pole as the UT day progresses. It is reversed after 17 or 18 hours UT.

This daily effect completely obscures any effect sunlit auroras might have on the frequency of auroral observations. (Sunlit auroras occur at heights above that of the earth's shadow.) The sunlit auroras should increase observations at 4 to 6 hours UT in that part of the sky nearer the sun, i.e., in the direction toward the geomagnetic pole. In fact, however, Table 1 records no auroras during these hours in this part of the sky. Instead, the maximum occurs in the opposite direction. Similarly, when the South Pole is between the sun and the magnetic pole, at about 16 hours UT, the majority of auroras are seen to occur in the direction opposite to the sun.

The daily effect is probably due to the apparent motion of the earth's magneti

TABLE 1
Frequency of Auroras Seen by South Pole Observers, 6/1/57–7/14/57, By Hour and Latitude

°S Lat.	86	87	88	89	90	89	88	87→(GMP)
UT								
00	15	18	15	5	7	12	15	
01	9	9	9	4	3	12	15	50
02	12	3		3	4			
03	9	6		2	5			
04	3				1			
05		6		2	1			
06	6		3	1	1			
07		3	6					
08	3	3	6	2	2			
09			3	2				
10	6		6	4	3			
11	3	12	3	2	5			
12	3			1	7			
13		9		5	6		15	
14			3	3	1	4		
15			3	1	3	12		
16				3	3	4		
17				1	3			
18		6	6	1	1	8	15	
19	3	9	12	7	4	12		
20	12	6	12	8	9	12	15	
21	3		9	5	5	12		50
22	12	18	6	6	6	8	15	
23	6	6	3	4	6	12	15	

Note: The unit used is the number of forms reported divided by the number of clear observation hours.

field with respect to the South Pole and the sun. This implies a seasonal effect.

Twilight Effect

The aurora sightings per hour are fairly constant until the sun climbs to a point about 18° below the South Pole's horizon. Then, sightings decline with the sun's continued rise toward the horizon. This twilight effect is probably physiological, i.e., the observers become unable to distinguish faint auroras against a brighter sky, rather than a physical effect in which sunlight in some way desensitizes the atmosphere to auroras. It is, therefore, advisable to treat with reserve data obtained when the solar angle of depression is less than 18°.

Second Brown Bear Cruise

The following material is based on a report submitted by Richard H. Fleming and staff, Department of Oceanography, University of Washington. An earlier IGY cruise of the Brown Bear *is described in* Bulletin No. 9.

During the summer of 1958, the oceanographic research vessel *Brown Bear,* of the University of Washington, carried out its second IGY cruise (*Brown Bear* Cruise 199). The ship left Seattle, Washington, on June 30, 1958, and returned on August 20. The cruise track covered an area of the Pacific generally west of the United States, reaching as far as 146°40′W, as far south as approximately 32°N, and including stops at San Diego and San Francisco, California (see Fig. 3).

The major objectives of the cruise were (a) to reoccupy hydrographic stations originally occupied by the research vessel *Carnegie,* in 1929, to determine what changes may have occurred in the properties of the deep water during the 29-year interval, and (b) to study the transition zone between Sub-Arctic and Sub-Tropic Water masses in the Northeast Pacific. In addition, a comprehensive program of oceanographic sampling was carried out along the cruise track.

This report outlines the observation program on the cruise and gives some of the preliminary results. It appears from these preliminary analyses that the warmer subtropical waters moved farther north than usual in the eastern Pacific during the summer of 1958.

Chief Scientist for the cruise was Maurice Rattray, Jr.; the *Brown Bear* was under the command of Captain F. W. Princehouse.

Observation Program

Routine observations were made at 42 hydrographic stations during the second IGY cruise of the *Brown Bear.* Three of these stations were inshore, contiguous to Puget Sound. In addition, a mid-water trawl was used to collect specimens for marine biology studies, and a program of albacore tagging was undertaken by R. L. Ridenhour, biologist, Oregon State Fish Commission.

Routine chemical analyses of sea water were carried out. The suspended matter filtered out of some samples will be subjected to spectrographic analyses to determine inorganic composition and distribution of trace elements (elements other than the eight relatively abundant rock-formers —O, Si, Al, Fe, Ca, Na, K, and Mg).

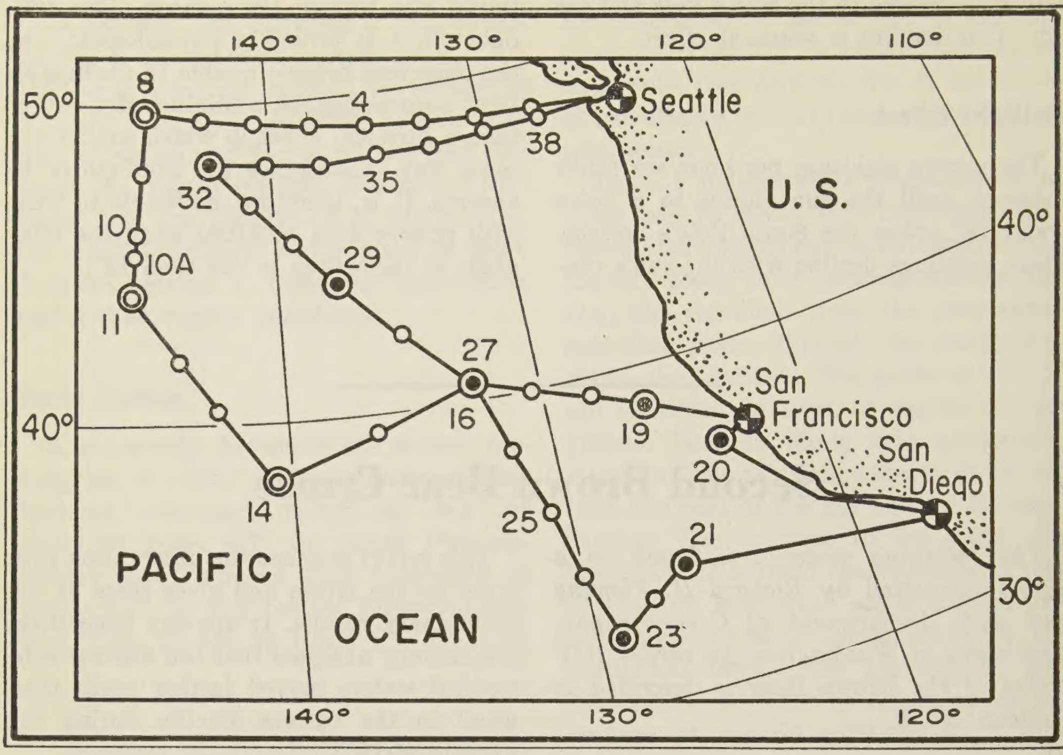

Fig. 3. *Track of Second IGY Cruise of* Brown Bear. *Single small circles represent standard hydrographic stations: double circles represent deep stations, with black dots signifying those previously occupied by the research vessel* Carnegie *(1929).*

Water samples for C-14 analysis were obtained from a depth of 100 meters above the bottom at 11 stations and from the minimum oxygen layer at 5 stations. (Some oceanographers believe that oxygen distribution in the ocean is closely related to water motion, and that layers of minimum oxygen content represent layers of minimum horizontal movement.)

Bottom cores were obtained along the cruise track to determine carbonate distribution and the magnesium-to-calcium ratio in carbonate bottom sediments.

Temperature-salinity curves and vertical sections of density were compiled for each hydrographic station occupied. Geopotential topographies of various pressure levels were also compiled. (Geopotential topography is determined by computing the varying values of density at any given depth. The horizontal hydrostatic pressure gradient determined from the density variation balances the Coriolis force—the effect of the earth's rotation on moving bodies; hence, study of geopotential topography supplies information on the strength and direction of currents. The pressure of the water is described in terms of decibars—1 decibar [10^5 dynes/cm^2] represents very nearly the force exerted by a column of water 1 meter high.)

Physical Oceanography

Brown Bear Cruise 199 covered the eastern portion of the transition zone between the Sub-Arctic and Central Water masses, including the region where the Sub-Arctic Current splits into the Alaska and California Currents.

(Sub-Arctic Water is cold, with temperatures of 35°–39°F, and has low salinity at

the surface. North of about 45°N it flows generally eastward, part of it turning north as it approaches the West Coast of the US and part turning south at the coast to mix with Equatorial Water in the vicinity of 25° N. The Central Water is warmer and more saline than Sub-Arctic Water, and may originate approximately within the region 30°–40°N, 150°–160°E. Intermediate Water generally occurs below Central Water in the vicinity of 36°N and is characterized by a salinity minimum layer. Equatorial Water occurs mostly south of about 15°N and is warmer and generally more saline than the other water masses.)

Water Masses: Temperature-salinity diagrams for the Northeast Pacific during the summer of 1958 indicate that the distribution of water-mass types was generally similar to that reported by Canadian oceanographers for the summers of 1955-57, although warmer waters apparently moved farther north than usual.

In summer 1958, Sub-Arctic Water was centered along 45°N, entering the cruise area from the west as a band about 100 miles wide and increasing in width toward the east. At 130°W, this band of water stretched almost from 40° to 50°N (a width of nearly 600 miles), and evidently marked the boundary region where the eastward-flowing Sub-Arctic Current splits northward into the Alaska Current and southward into the California Current. Since the contours of geopotential topography spread apart (indicating weak pressure gradients) as they approached the coast (see Figs. 4 and 5), it appears that this wide band of Sub-Arctic Water had accumulated in a large area of weak currents off the coast.

Water below the halocline (zone of rapid increase of salinity, just beneath the surface layer) consisted of mixtures of Sub-Arctic Water with (a) Intermediate Water, (b) Central Water, or (c) Equatorial Water.

In the southeastern half of the cruise area, an appreciable amount of Equatorial Water was mixed with the Sub-Arctic Water at depths greater than 1100–1900 feet (depending upon location).

Between these levels and the halocline, the water consisted of a mixture of Sub-Arctic and Intermediate Waters. Intermediate Water made up a large proportion of the mixture generally in the southwestern part of the cruise area, and there seemed to be appreciable amounts in the central, east-central, and northeast part of the area. In the extreme southern and southwestern part of the cruise area, some Central Water could be found between the bottom of the halocline and the top of Intermediate Water layer.

Geopotential Topography: South of 50°N and west of 135°W, the geopotential topography of the surface relative to the 1200-decibar level (see Fig. 4) indicated a north-

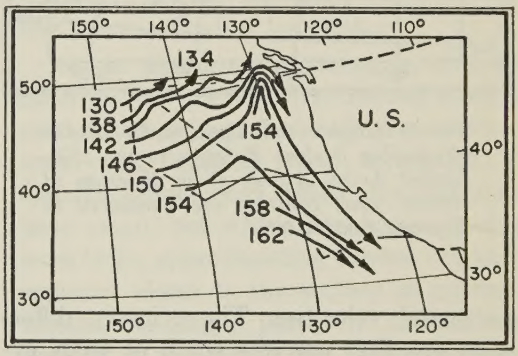

FIG. 4. *Geopotential Topography of the Sea Surface Relative to the 1200-decibar Level in the Cruise Area. Arrows show direction of current flow; contours are numbered in dynamic centimeters. (A dynamic centimeter represents the amount of work required to move a given mass through a vertical distance of one centimeter).*

easterly flow of Sub-Arctic Water; east of 130°W, southeasterly flow is indicated in these latitudes. Water crossing the 50°N parallel in the region west of 130°W apparently continued northward into the Gulf of Alaska.

The surface geopotential topography varies considerably from year to year in this region. The most notable features for 1958, compared to the previous three summers, were the existence of a northward component of flows over the whole western part of the area and concentration of the contours (indicating greater velocities) near 49°N, the highest such concentration during the period 1955–58.

The geopotential topography of the 200-decibar level relative to the 1200-decibar level had the same general features as that of the sea surface (see Fig. 5), but with

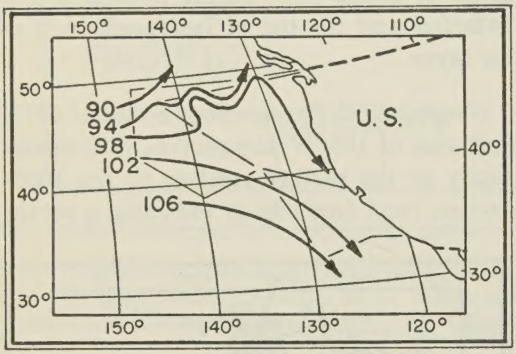

FIG. 5. *Geopotential Topography of the 200-decibar Surface Relative to the 1200-decibar Level. Arrows show direction of current flow; contours are numbered in dynamic centimeters.*

decreased velocities. The primary difference was that currents south of 45°N everywhere tended toward the south rather than toward the north, as they did at the surface west of 130°W.

Current Velocities: Throughout the cruise area, average currents were weak—about one mile per day—although locally currents at times reached 4–7 miles per day. The highest velocities were present near the coast of Washington State between 48°N and 50°N, where a portion of the northeast-flowing Sub-Arctic Current turns southeast along the coast. A region of rather weak currents, centered at abou 45°N, 130°W, corresponded to a pressu ridge around which this stronger curren flowed.

At the 200-decibar level, the stronge currents lay along a line from about 45°N 146°W, to 49°N, 130°W, defining the fron between the Sub-Arctic and Intermedia Water masses. Vertical sections of densi verify the position of this front.

Temperatures: Unusually high surfa temperatures and deeper-than-averag thermoclines were evident in 1958. (Th thermocline is a layer in which temperatu decreases rapidly with depth.) The lowe surface temperature, 53.5°F, was measure in the northwest corner of the cruise are with temperatures increasing toward th south and the east. The maximum tempera ture, 68.9°F, was observed at approximatel 39°N, just north of Station 26 (Fig. 1).

The warmer-than-usual surface tempera tures lay roughly in the region south o the subsurface front marking the transitio between Sub-Arctic and Intermediate Wa ters and north of a surface front, 165–33 feet deep, at about 40°N near Station 1 This surface front also gave a southe limit to the currents turning northwa along 130°W.

The vertical temperature structure wa generally characterized by (a) a relativel uniform upper layer, (b) a thermocli layer, and (c) a layer in which the tempe ature gradient was small and decrease with depth. The maximum temperatu gradient was generally near the top of th thermocline, at a depth of about 100 fee Offshore, the thermocline appears to hav been deeper in 1958 than the average f the period 1941-52; farther west it becam shallower.

Rough estimates of the rate of chan of surface temperatures were made in di ferent parts of the cruise track on bot outbound and return legs. They were follows:

Areas	*°F/month*
Stations 16, 27	6.0
" 7, 8, 9, 32	1.6
" 1, 38	1.3

Conclusions: Departures from normal in this region during 1958 seemed to result from differences in surface flow, which in turn strongly suggests that these departures were caused ultimately by differences in the related wind systems. There is also evidence, however, that the flow in this region is inherently unstable, in which case the 1958 conditions may represent a northward "meander" of the water masses.

Marine Biology

Midwater Trawling: Over 300 trawls were made, with 3 to 8 samples taken almost every night. Daylight trawls were also made for comparison. The distribution of marine fauna reflected the higher than average temperatures and the transitions from one water mass to another.

Preliminary examination of the trawl samples revealed the following:

(a) Catches close to the coast, particularly in the northern part of the cruise area, were surprisingly small compared with those obtained during the first IGY cruise of the *Brown Bear*. These small catches appear to be related to the relatively high temperature of the inshore waters, which suggests a tongue of water encroaching from the south. West of about 133°W, catches approximated those of the earlier cruise. The largest catches were made in the northwest corner of the area.

(b) In the northern areas, a pronounced thermocline seemed to act as a barrier to the plankton. (Plankton—floating or weakly swimming animal and plant life—is a basic food resource for other marine life.) Catches were extremely small in hauls made above the thermocline. In the single exception, a large catch taken in a shallow haul between stations 37 and 38, most of the animals appeared typically southern. The peak abundance occurred below the thermocline, at a depth of 200 feet; these catches were typically northern.

(c) A definite change in the character of the marine life occurred between stations 9 and 11, corresponding to the transition zone between Sub-Arctic and Intermediate Water. Hauls taken between stations 9 and 10 showed typically northern populations, whereas hauls just south of station 10 were lower in plankton volume and more typically southern. At least eight fish species not captured to the north were taken south of station 10; large catches of hatchet fish, *Argyropelecus spp.*, were particularly unusual. On the return leg of the cruise, the faunal split occurred between stations 30 and 32.

(d) Plankton catches with the midwater trawl were very small south of 37°N, except in hauls made close to the California coast. The offshore catches were approximately 1/100 the volume of hauls made to the north at similar longitudes.

(e) An extensive temperature inversion layer at 400–500 feet, first noticed south of station 10A, was probed with the midwater trawl and followed south to station 14. Catches above and below the inversion were small, but within the inversion they were large, approximating catches normally expected closer to the surface in northern waters. Although plankton catches decreased in volume to the south, the peak catches were always made within the inversion layer.

(f) Numerous bathypelagic (deep-sea) fishes were captured during the cruise. The largest fish caught was a 4-foot specimen of the king of the salmon, *Trachypterus rex-salmonorum;* several larvae and juveniles of this fish were also taken.

Albacore Tagging: Albacore were trolled for and tagged between Seattle and San Diego. From June 30 to July 23, a total of 38 albacore was caught, of which 29 were

tagged. This species of tuna, 15–30 inches long and weighing 4–30 pounds, is commonly found in temperate and tropical waters. Tagging supplies information on migration patterns, population composition, and sometimes on growth patterns of the fish.

A large concentration of albacore was found at approximately 46°N, 146°30′W, on July 11. Surface-water temperatures were 57° to 58°F; analysis for possible relationships with other local oceanographic conditions must await further processing of the available data. Other catches were sporadic and indicated no appreciable concentrations of albacore.

Stomach analyses of the untagged fish indicated that sauries (narrow-bodied, spiny-finned fish with widely-forked tails) were their principal food, with pelagic shrimp, squid, and amphipods (crustaceans resembling sand fleas) also noted.

Antarctic Notes

Continental Structure

New Zealand scientists, interpreting seismic records obtained during the IGY at Scott Base (NZ) and Hallett Station (NZ-US), report the existence of continent-type crustal structure beneath the ice mantle of a large portion of East Antarctica. The report, by F. F. Evison, C. E. Ingham, and R. H. Orr, of the New Zealand Department of Scientific and Industrial Research, appeared in *Nature*, January 31, 1959.

Records of the dispersion of seismic waves traveling through the crustal rocks from their point of origin, the epicenter of an earthquake in the southeast Indian Ocean on September 9, 1957, were analyzed. They showed the earth's crust to be approximately 35 kilometers thick in the region from the Wilkes Coast east of US-IGY Wilkes Station to the Ross Sea area, a distance of about 2000 km. (Preliminary analyses for an earthquake that occurred in the southwest Indian Ocean on August 4, 1957, also show a crustal thickness of about 35 kilometers for East Antarctica.) The normal thickness beneath continents ranges from about 30 to 40 kilometers. "Thus," the report states, "the existence of a true Antarctic continent is confirmed."

In the US program, analyses of dispersion of surface seismic waves from earthquakes in oceanic areas adjacent to the US-IGY Wilkes Station also suggest continental structure in this part of the Antarctic. These analyses indicate an average crustal thickness of about three-fourths the value considered normal for continents. On the basis of data gathered throughout the Antarctic during the IGY, G. P. Woollard, member of the USNC-IGY Technical Panel on Seismology and Gravity, has stated: "After even a crude calculation . . . it appears that the eastern half of Antarctica is a continent and the western half is an archipelago of islands bridged over by ice."

Traverse to Executive Committee Range

As part of the continuing US program in Antarctica, now under the direction of the National Science Foundation, an oversnow traverse to the Executive Committee Range, about 230 miles northwest of Byrd Station, was made by members of the station's scientific staff in February and early March of 1959. The traverse was led by John Pirrit, Station Scientific Leader at Byrd Station and Glaciological Project Leader for the 1959 Antarctic Program.

The party spent two days at the range

determining the positions of the peaks, making glaciological studies, and conducting a preliminary geological reconnaissance. Ten peaks were found in the range, the smallest reaching a height of 7144 feet above sea level and the largest reaching 13,856 feet. The range trends north-south for about 60 miles between about 76°20′S and 77°20′S and approximately along the 126°W meridian.

Preliminary geological investigations indicated that the mountains are volcanic in origin and are about 90% covered by snow and glaciers. Alpine-type valley glaciers flow from the peaks to join the vast ice sheet of Marie Byrd Land. Glacier action has eroded and modified the volcanic craters so that their original shapes are no longer recognizable. The high peaks are composed almost entirely of varieties of basalt overlaid by a thick series of volcanic breccias and tuffs. (Basalt is a fine-grained, dark, igneous rock commonly occurring as lava flows; breccias and tuffs are rocks formed of material ejected from volcanoes and subsequently compacted; the tuffs are fine-grained and the breccias are coarser and angular.)

An unusual and as yet unexplained finding was also made. Hundreds of black, partly rounded rocks of vesicular basalt (basalt containing cavities formed by gas bubbles when the rock was cooling) were discovered in one area. The rocks, generally 4–8 inches in diameter, were scattered over the surface of the ice sheet in the vicinity of several of the peaks. They were very numerous as far out as about two miles from the peaks, and isolated rocks were found as far away as approximately 17 miles.

The rocks were not distributed in the normal patterns characteristic of glacier deposits, or moraines; moreover, the glacier flow-rate was estimated to be not more than 50–100 feet per year, and many years would therefore have been required for the glaciers to move the rocks to their present positions. To further complicate the problem, the rocks do not show the alteration to be expected from differential rates of glacier flow, and appear to have been recently emplaced. Additional investigations will be required to determine how and when the rocks were deposited.

Position of IGY Amundsen-Scott South Pole Station

A more accurate determination of the geographic position of the IGY South Pole Station has recently been made. Computations based on 52 direct and inverted (to eliminate instrumental errors) theodolite observations of the star Canopus, from the station's astronomical loft, place the position of the loft at 89°59′43.6″ ± 0.7″ South Latitude, 24.8° ± 2.4° West Longitude. (Since the meridians of longitude converge at the poles, it is difficult to obtain the same apparent accuracy in longitude determinations at very high latitudes as in latitude determinations. However, only very small ground distances are involved so the actual accuracy is approximately the same.)

The Canopus observations were made between May 25 and July 6, 1958, by Palle Mogensen, then Station Scientific Leader at the IGY Amundsen-Scott Station, and the computations were performed by the Gravity and Astronomy Branch, Geodesy Division, of the US Coast and Geodetic Survey.

The astronomical loft is in the southernmost building of the station, which is laid out in a linear pattern roughly along the Greenwich Meridian and on the Greenwich side of the Pole. This latest determination places the position of the loft approximately 1650 feet from the geographic South Pole. It appears that the position is reliable to within 100–200 feet, exclusive of the "deflection of the vertical" (plumb-line deflection owing to gravity variations, as yet undetermined for the South Pole vicinity) at the observing site.

Firn Quakes

Two "firn quakes" were experienced by members of the oversnow traverse from IGY Byrd Station during the Antarctic summer of 1957–58. A firn quake is an icecap phenomenon somewhat resembling an earthquake but, by comparison, greatly limited in depth, areal extent, and severity.

These quakes are apparently confined to the firn—snow or granular ice that has lasted through at least one summer but has not yet become sufficiently compacted to be termed glacial ice. Firn reaches to depths of a few hundred feet in many places on the icecap. Firn quakes may be caused in several ways, but it is thought they frequently result from the collapse of widespread hoar-frost layers a few years old under the weight of overlying firn and snow.

Both quakes were felt during the third leg of the 1957–58 Byrd Station traverse. The first quake is believed to have occurred naturally, but the second was apparently triggered by an explosion set off in the course of seismic studies by members of the traverse party.

The first of the two firn quakes occurred about 90 miles southwest of the Sentinel Mountains, the turning point between the second and third legs of the traverse. The icecap in the region of the quake is about 5300 feet thick and the surface is about 6600 feet above sea level. The actual shock of the quake was preceded for about 10 seconds by a low, wind-like noise coming roughly from the direction of the Sentinel Mountains. The sound grew in intensity, as if approaching rapidly, until comparable to that of a jet aircraft passing overhead. The culmination of the phenomenon was a sharp, cracking sound accompanied by a sudden, distinct shock. No diminishing sound comparable to the pre-shock noise was noticed after the shock, and no indication of cracking could be found in the nearby ice surface. Moreover, examination of the walls of a three-meter snow pit excavated subsequently at the site of the quake disclosed no apparent collapse of any particular snow or firn horizon.

The second firn quake occurred about 170 miles farther along the traverse route two weeks later. At this point, an ice thickness of about 8600 feet and a surface elevation of 6700 feet were measured. The area was flat and featureless and about 65 miles west of the nearest mountains.

During seismic refraction studies, a member of the seismic team set off a 10-lb charge of explosives at a depth of about 13 feet in the snow cover and approximately 2.5 miles from camp. The shock that followed was greater than that ordinarily accompanying such an explosion. It was felt both by the scientist setting off the charge and by other members of the traverse party, 2.5 miles away. The noise preceding the quake, and the shock itself, were similar to those of the first quake, but this time the shock was followed by a receding noise in the direction opposite to that from which the pre-shock noise had come (the seismic shot point). Glaciologists working in a three-meter pit at the time of the quake observed no collapse of any of the snow or firn layers exposed in the pit walls.

Operation "Snuffles"

Work now is under way at Johns Hopkins University and the National Institutes of Health on hundreds of samples of blood sera, virus cultures, and bacterial cultures taken from US-IGY personnel in or en-route to and from the Antarctic.

The research is aimed at finding out more about the common-cold-like upper respiratory complaints. Answers are sought to questions such as these: Do the viruses associated with colds disappear from isolated groups? Do such groups lose their immunity to colds while sheltered from outside contacts? And the even more basic questions, exactly what causes the colds they catch, and how can these be counteracted?

Since isolated communities usually remain free from "colds" until visited by new people, the IGY Antarctic program provided an ideally controlled test situation.

The icebreaker *USS Staten Island* served as a floating laboratory for the project. All officers and men aboard gave samples of their blood at the beginning of the voyage and before their return to the US. In addition, 56 volunteers were studied closely throughout the entire voyage. Each gave a blood sample about once a month, and submitted to 15 throat swabs for virus cultures and 30 nose and throat swabs for bacteria. The specimens were collected mostly before and after visits to ports on the way south and in the Antarctic.

The information obtained aboard ship will indicate what infections were present in this semi-isolated community, and what infections could have been transmitted from it to the isolated and semi-isolated IGY Antarctic communities visited.

The *Staten Island* visited IGY Hallett Station (NZ-US), regarded as semi-isolated, and US-IGY Wilkes Station, which had been completely isolated for one year. Blood samples and swabs were taken from personnel of both stations.

Equipment was left at the Antarctic Research Laboratory, NAF McMurdo, for use in taking samples during the current Antarctic winter isolation. Samples also are being collected now at the South Pole, Hallett, and Wilkes Stations.

During the six-month voyage of the *Staten Island,* somewhat less than half the ship's company complained of "colds", many soon after leaving the various ports of call. From the swabs taken during these symptoms it is hoped to isolate some of the causal agents and match them with the antibodies later developing in the blood, or to differentiate them from true bacterial infections.

It remains to be seen if viruses found in the *Staten Island* volunteers can be picked up from personnel who joined the ship at Wilkes, or if the antibody experience of the Wilkes personnel parallelled that of ship personnel. Also significant will be the comparison of blood and swabs taken from Wilkes men before and after their isolation ended.

In its six months of operation, the *Staten Island* laboratory collected more than 900 samples of blood sera, more than 1300 virus cultures, and 2660 bacteria cultures.

To bring the sera and cultures back safely was a feat of logistics. It was necessary to maintain temperature for the virus cultures at a maximum of −60°C. The two freezers used for this purpose would not fit through the hatch, so a part of the metal bulkhead had to be removed and welded up again after the freezers were installed. When the ship returned to Seattle, the Air Force flew the freezers to Andrews Air Force Base, Maryland, in a C-97 cargo aircraft carrying two generators to provide the necessary emergency power.

William J. L. Sladen, the Project Director, assisted by Rainer Goldsmith of the Medical Research Council, London, was responsible for the field work. Sladen and others at Johns Hopkins University will work on the bacteriological material. Robert M. Chanock is doing the virus analysis at the Respiratory Virus Unit, National Institutes of Health.

J. W. Potter, Navy medical officer at NAF McMurdo, is continuing the investigation at the Antarctic Research Laboratory, and J. Boda, Australian medical officer, is doing likewise at Wilkes Station. "Operation Snuffles" also had the helpful cooperation of the Navy medical officers at Wilkes (R. Sparkes) and Hallett Stations (R. Bornmann and A. Bridgeman), and aboard the *USS Staten Island* (R. Duckworth) and *USS Glacier* (C. Stover). Australian, New Zealand, and British personnel also participated.

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